REMARKS / ARGUMENTS

This application is believed to be in condition for allowance because the claims are believed to be non-obvious and patentable over the cited references. The following paragraphs provide the justification for this belief. In view of the following reasoning for allowance, the Applicant hereby respectfully requests further examination and reconsideration of the subject patent application.

1.0 Amendments to the Specification:

In the specification of the application, as originally filed, Applicants referenced a related application, referred to by application title, and the use of "TBD" placeholders with respect to the filing date and serial number of various related applications. In particular, the "TBD" placeholder was used in paragraphs [0031], [0082], [0087] and [0087] since, at the time of filing, the serial number and/or filing date of the related application was not known.

Specifically, Applicants have amended US Patent Application Publication No. 2005-0195988 A1 (US Application No. 10/792,313) to refer to several earlier filed co-pending patent applications. No new matter is introduced by way of the above described amendments.

2.0 Rejections of Independent Claims 1, 15 and 26 under 35 U.S.C. §103(a):

In the Office Action of July 30, 2007, claims 1, 3-7, 9, 15-16, 18-20, 22, and 26-28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Nordholm, et al, paper entitled "ADAPTIVE MICROPHONE ARRAY EMPLOYING CALIBRATION SIGNALS: An Analytical Evaluation" (hereinafter "***Nordholm***").

In order to deem the Applicants' claimed invention unpatentable under 35 U.S.C. §103(a), a *prima facie* showing of obviousness must be made. However, as fully

explained by the M.P.E.P. Section 706.02(j), to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, ***the prior art reference (or references when combined) must teach or suggest all the claim limitations***.

Further, in order to make a *prima facie* showing of obviousness under 35 U.S.C. 103(a), all of the claimed elements of an Applicants' invention must be considered, especially when they are missing from the prior art. If a claimed element is not taught in the prior art and has advantages not appreciated by the prior art, then no *prima facie* case of obviousness exists. The Federal Circuit court has stated that it was error not to distinguish claims over a combination of prior art references where a material limitation in the claimed system and its purpose was not taught therein (*In Re Fine*, 837 F.2d 107, 5 USPQ2d 1596 (Fed. Cir. 1988)).

In view of the following discussion, the Applicants will show that one or more elements of the Applicants claimed methods, systems, and computer executable instructions are missing from the cited art, and are not obvious in view of the cited art. As such, the Applicants claimed methods, systems, and computer executable instructions are patentable over that cited art.

2.1 Rejection of Claims 1, 3-7 and 9:

In general, the Office Action rejected independent claim 1 under 35 USC §103(a) based on the rationale that the ***Nordholm*** reference teaches the Applicants' claimed "method for real-time design of beam sets for a microphone array from a set of pre-computed noise models…" However, in view of the following discussion, Applicants will show that the ***Nordholm*** reference does not teach the Applicants claimed method, and that the ***Nordholm*** reference has been mischaracterized in an attempt to show some

equivalence to the claimed method. As such, Applicants respectfully traverse the rejection of claims 1, 3-7 and 9 under 35 USC §103(a) over the ***Nordholm*** reference.

First, Applicants respectfully suggest that the ***Nordholm*** reference fails completely to disclose or in any way render obvious any of the elements of the claimed method since the ***Nordholm*** reference is not directed at the same problem solved by the claimed method and fails to disclose or render obvious any of the elements of the claimed method. For example, the ***Nordholm*** reference discloses a technique for using a ***calibration signal*** as part of an analytical evaluation that ***requires a person to read representative sentences*** that are combined and processed in order to calibrate a microphone array. See for example, FIG. 1 and Section II (page 242) of the ***Nordholm*** reference, which includes the following discussion of the "Calibration Phase" of operations:

> "*A. Description of the Calibration Phase*
>
> The adaptive beamformer can be ***calibrated on site in a parked car (see Fig. 1) by emitting calibration signals from the existing hands-free loudspeaker and by letting a talker read representative sequences either directly or via a loudspeaker in what would be the talker's position***. The environmental noise level in a parked car is very low, thereby providing a good SNR during recording. These sequences are gathered into a memory. This means that information about the paths of acoustic propagation from the sources to A/D-converters are included. The beamformer has shown robust behavior with respect to changes in the driving conditions, number of passengers, etc. This is at least valid for suppressions of the hands-free loudspeaker (jammer) up to 15 dB. Experience shows that a set of gathered calibration signals can be used for weeks. To obtain suppression ratios of more than 25 dB, it is necessary to gather and recalibrate more frequently." (emphasis added)

In contrast, the claimed method does not use a calibration signal of any kind. Further, the claimed method does not require a person to read representative sentences

either with or without the presence of a calibration signal. In addition, unlike the ***Nordholm*** reference the claimed method is not directed at calibrating a microphone array using combinations of discrete speech and calibration signals.

More specifically, in rejecting claim 1, the Office Action first suggests that FIG. 3 of the ***Nordholm*** reference discloses the use of "…pre-computed noise models…" However, FIG. 3 of the ***Nordholm*** reference simply does not show the use of pre-computed noise models, nor is any discussion of pre-computed noise models found in the text of the ***Nordholm*** reference. In particular, FIG. 3 of the ***Nordholm*** reference shows three inputs, as follows: 1) an input signal x(t) provided to a box labeled "Anti-Aliasing and A/D Conversion"; 2) a pre-recorded copy of the "calibration signal" being provided via a box labeled "Memory Jammer calibration signals"; and 3) a pre-recorded copy of a person reading sentences in a "parked car."

In fact, in the last sentence on page 242, ***Nordholm*** discusses the "Jammer Calibration Signal" by explaining that "The stored jammer and target (desired) signals are known ***<u>noise-free signals</u>*** (see Fig. 1)…" Clearly, the "calibration signal" is not a "pre-computed noise model" since it is a "known noise free signal." Similarly, the recorded speech of a person reading sentences in a parked car is not a "pre-computed noise model." Finally, the real-time signal input x(t) is clearly not a "pre-computed noise model." As such, it is clear that FIG. 3 of the ***Nordholm*** reference fails to disclose the use of "pre-computed noise models."

Next, the Office Action suggests that Section II, beginning on page 242, of the ***Nordholm*** reference (entitled "Working Scheme for the Adaptive Beamformer") discloses the claimed element of "***compute a set of complex-valued gains for each subband of a frequency-domain decomposition of microphone array signal inputs for each of a plurality of beam widths*** within a range of beam widths, said sets of complex-valued gains being computed from the pre-computed noise models in combination with known geometry and directivity of microphones comprising the microphone array…"

However, in contrast to the position advanced by the Office Action, it is clear that the ***Nordholm*** reference fails completely to disclose the aforementioned claim element, or in any way render that element obvious. For example, Section II of the ***Nordholm*** reference clearly describes the use of a generic beamformer which is summarized by the use of Equation (2) which illustrates a generic technique for providing a beamformer output $u[k]$ from a weighted beamformer input (see page 243 of the ***Nordholm*** reference). More specifically, as illustrated by FIG. 3 of the ***Nordholm*** reference, the "Upper Beamformer" output $u[k]$ is computed based on the microphone array signal input in combination with an output from a "lower beamformer" that is computed based on a combination of previously recorded speech, previously recorded calibration signals, and a copy of the microphone array input.

In contrast, Applicants specifically claim computing "***a set of complex-valued gains for each subband of a frequency-domain decomposition of microphone array signal inputs for each of a plurality of beam widths…***" Applicants further specifically claim that this "set of complex-valued gains" is computed based on "pre-computed noise models in combination with known geometry and directivity of microphones comprising the microphone array…" These features are simply not disclosed or in any way rendered obvious by the ***Nordholm*** reference.

Next, the Office Action suggests that the "Upper Beamformer" of the ***Nordholm*** reference discloses the claimed element of "***search the sets of complex-valued gains to identify a single set of complex-valued gains for each frequency-domain subband and for each of a plurality of target focus points around the microphone array…***"

However, it has been established that the ***Nordholm*** reference fails to disclose any process for computing "***a set of complex-valued gains…***" as claimed by the Applicants. As such, the ***Nordholm*** reference is inherently incapable of searching such a set of ***complex-valued gains*** for the specific purpose of identifying "***a single set of complex-valued gains for each frequency-domain subband and for each of a plurality of target focus points around the microphone array…***"

Further, the ***Nordholm*** reference describes both the "Upper Beamformer" and the "lower beamformer" on page 243. For example, ***Nordholm*** explains that the "input signals to the upper beamformer… contain the microphone signal only…" In addition, ***Nordholm*** also explains on page 243 that the lower beamformer uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input to determine filter weights which are then passed to the upper beamformer for use with the current microphone array input.

Clearly, the dual-level beamformer process based on the use of live and pre-recorded signals described by the ***Nordholm*** reference fails completely to disclose or in any way render obvious any process for ***searching*** "***the sets of complex-valued gains to identify a single set of complex-valued gains for each frequency-domain subband and for each of a plurality of target focus points around the microphone array…***"

Finally, the Office Action suggests that the ***Nordholm*** reference discloses the claimed element of "***wherein each said set of complex-valued gains is individually selected as the set of complex-valued gains having a lowest total noise energy relative to corresponding sets of complex-valued gains for each frequency-domain subband*** for each target focus point around the microphone array" (emphasis added). In particular, the Office Action suggests that this feature, which limits the selection of the claimed set of complex-value gains, is disclosed by the "Upper Beamformer output" as illustrated by FIG. 3 of the ***Nordholm*** reference. The Office Action then continues in the rejection of this element by suggesting that the remainder of the element, which recites "***wherein each selected set of complex-valued gains is then provided as an entry in said beam set for the microphone array***" (emphasis added) is disclosed by the "Lower Beamformer" of the ***Nordholm*** reference.

There are several problems with this last argument presented by the Office Action with respect to this last element of claim 1. For example, the Office Action is apparently suggesting that the "Upper Beamformer output" discloses the claimed "sets of complex

value gains." However, the output of the "Upper Beamformer" is a ***time-domain audio signal***, $u[k]$. Clearly, a time-domain audio signal is ***not*** a set of complex-value gains.

Further, this time-domain audio signal output by the Upper Beamformer is ***not*** provided back to the "Lower Beamformer" as suggested by the Office Action (see the very large arrow pointing from the Lower Beamformer to the Upper Beamformer in FIG. 3 of the ***Nordholm*** reference. Specifically, the Office Action suggests that the output of the Upper Beamformer is provided to the Lower Beamformer and that this somehow discloses the claimed element of "***wherein each selected set of complex-valued gains is then provided as an entry in said beam set for the microphone array***."

Applicants respectfully suggest that this is a clear mischaracterization of the ***Nordholm*** reference since, as discussed above, the Lower Beamformer of the ***Nordholm*** reference simply uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input t***o determine filter weights which are then passed to the upper beamformer*** for use with the current microphone array input.

In summary, Applicants claim a method that is specifically directed at automatically designing an optimized set of steerable beams for microphone arrays of arbitrary geometry and microphone type by determining optimal beam widths as a function of frequency to provide optimal signal-to-noise ratios for in-beam sound sources while providing optimal attenuation or filtering for ambient and off-beam noise sources. This automatic beamforming involves a novel process that automatically determines optimal frequency-dependant beam widths given local noise conditions and microphone array operational characteristics. Claim 1, as drafted, specifically defines the elements and limitations of these points. In contrast, the elements of claim 1 are clearly not disclosed by the ***Nordholm*** reference.

Therefore, in view of the preceding discussion, it is clear that independent claim 1 has elements not disclosed in the ***Nordholm*** reference. Consequently, the rejection of claim 1 under 35 USC §103(a) is not proper. Therefore, Applicants respectfully traverse

the rejection of claim 1 and request reconsideration of the rejection of claim 1, and thus of dependent claims 3-7 and 9, under 35 USC §103(a) in view of the language of claim 1. In particular, claim 1 recites the following novel language:

> "A method for real-time design of beam sets for a microphone array from a set of pre-computed noise models, comprising using a computing device to:
>
> ***compute a set of complex-valued gains for each subband of a frequency-domain decomposition of microphone array signal inputs for each of a plurality of beam widths within a range of beam widths***, said sets of complex-valued gains being computed from the ***pre-computed noise models*** in combination with known geometry and directivity of microphones comprising the microphone array;
>
> ***search the sets of complex-valued gains to identify a single set of complex-valued gains for each frequency-domain subband and for each of a plurality of target focus points around the microphone array***; and
>
> ***wherein each said set of complex-valued gains is individually selected as the set of complex-valued gains having a lowest total noise energy relative to corresponding sets of complex-valued gains for each frequency-domain subband*** for each target focus point around the microphone array, and wherein each selected set of complex-valued gains is then provided as an entry in said beam set for the microphone array."
> (emphasis added)

2.2 <u>Rejection of Claims 15-16, 18-20 and 22:</u>

In general, the Office Action rejected independent claim 15 under 35 USC §103(a) based on the rationale that the ***Nordholm*** reference teaches the Applicants' claimed "system for automatically designing beam sets for a sensor array …" However, in view of the following discussion, Applicants will show that the ***Nordholm*** reference does not teach

the Applicants claimed system, and that the ***Nordholm*** reference has been mischaracterized in an attempt to show some equivalence to the claimed system. As such, Applicants respectfully traverse the rejection of claims 15-16, 18-20 and 22 under 35 USC §103(a) over the ***Nordholm*** reference.

First, Applicants respectfully suggest that the ***Nordholm*** reference fails completely to disclose or in any way render obvious any of the elements of the claimed system since the ***Nordholm*** reference is not directed at the same problem solved by the claimed system and fails to disclose or render obvious any of the elements of the claimed system. Further, Applicants note that in rejecting independent claim 15, the Office Action merely states "Claim 15 has been analyzed and rejected according to claims 1 & 9."

However, claim 15 includes a set of limitations that are different from the limitations specified in claims 1 and 9. As such, the rejection of claim 1 fails completely to specifically address any of the limitations of independent claim 15. Therefore, since the specific limitations of claim 15 are not addressed in rejecting claim 15, Applicants respectfully suggest that the Office Action has failed to present the *prima facie* case for rejection required under M.P.E.P. Section 706.02(j).

Consequently, rather than attempt to compare the elements of claim 15 to the elements of claim 1 and then further attempt to connect those elements to the arguments presented by the Office Action with respect to claim 1, Applicants will instead generally explain how the problem being addressed by the claimed system differs from the disclosure provided by the ***Nordholm*** reference. Since no *prima facie* case for rejection has been presented, this should be more than sufficient to rebut the contention of obviousness under 35 USC §103(a).

For example, the ***Nordholm*** reference discloses a technique for using a ***calibration signal*** as part of an analytical evaluation that ***requires a person to read representative sentences*** that are combined and processed in order to calibrate a microphone array.

See for example, FIG. 1 and Section II (page 242) of the ***Nordholm*** reference, which includes the following discussion of the "Calibration Phase" of operations:

> "*A. Description of the Calibration Phase*
>
> The adaptive beamformer can be ***calibrated on site in a parked car (see Fig. 1) by emitting calibration signals from the existing hands-free loudspeaker and by letting a talker read representative sequences either directly or via a loudspeaker in what would be the talker's position***. The environmental noise level in a parked car is very low, thereby providing a good SNR during recording. These sequences are gathered into a memory. This means that information about the paths of acoustic propagation from the sources to A/D-converters are included. The beamformer has shown robust behavior with respect to changes in the driving conditions, number of passengers, etc. This is at least valid for suppressions of the hands-free loudspeaker (jammer) up to 15 dB. Experience shows that a set of gathered calibration signals can be used for weeks. To obtain suppression ratios of more than 25 dB, it is necessary to gather and recalibrate more frequently." (emphasis added)

In contrast, the claimed system does not use a calibration signal of any kind. Further, the claimed system does not require a person to read representative sentences either with or without the presence of a calibration signal. In addition, unlike the ***Nordholm*** reference the claimed system is not directed at calibrating a microphone array using combinations of discrete speech and calibration signals.

With respect to the claimed computation and use of "…noise models…," the figures of the ***Nordholm*** reference simply do not show the use of pre-computed noise models, nor is any discussion of noise models found in the text of the ***Nordholm*** reference. In particular, FIG. 3 of the ***Nordholm*** reference shows three inputs, as follows: 1) an input signal x(t) provided to a box labeled "Anti-Aliasing and A/D Conversion"; 2) a pre-recorded copy of the "calibration signal" being provided via a box labeled "Memory Jammer

calibration signals"; and 3) a pre-recorded copy of a person reading sentences in a "parked car."

In fact, in the last sentence on page 242, ***Nordholm*** discusses the "Jammer Calibration Signal" by explaining that "The stored jammer and target (desired) signals are known ***noise-free signals*** (see Fig. 1)…" Clearly, the "calibration signal" is not a "noise model" since it is a "known noise free signal." Similarly, the recorded speech of a person reading sentences in a parked car is not a "noise model." Finally, the real-time signal input x(t) is clearly not a "noise model." As such, it is clear that FIG. 3 of the ***Nordholm*** reference fails to disclose the use of "noise models."

Further, Section II of the ***Nordholm*** reference clearly describes the use of a generic beamformer which is summarized by the use of Equation (2) which illustrates a generic technique for providing a beamformer output $u[k]$ from a weighted beamformer input (see page 243 of the ***Nordholm*** reference). More specifically, as illustrated by FIG. 3 of the ***Nordholm*** reference, the "upper beamformer" output $u[k]$ is computed based on the microphone array signal input in combination with an output from a "lower beamformer" that is computed based on a combination of previously recorded speech, previously recorded calibration signals, and a copy of the microphone array input.

In contrast, Applicants specifically claim elements including "***defining a set of target beam shapes*** as a function of a set of target beam focus points and a range of target beam widths, said target beam focus points being spatially distributed within a workspace around the sensor array; defining a ***set of target weight functions to provide a gain for weighting each target focus point*** depending upon the position of each target focus point relative to a particular target beam shape; ***computing a set of potential beams by computing a set of normalized weights for fitting the directivity pattern of each microphone into each target beam shape throughout the range of target beam widths across a frequency range of interest for each weighted target focus point***…" These features are simply not disclosed or in any way rendered obvious by the ***Nordholm***

reference, or is any *prima facie* case or argument presented by the Office Action with respect to these claimed limitations.

For example, ***Nordholm*** explains on page 243 that the “Lower Beamformer” uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input to determine ***filter weights*** which are then passed to the upper beamformer for use with the current microphone array input. Clearly, “***filter weights***” applied to microphone array input signals by the “Upper Beamformer” of the ***Nordholm*** reference fail completely to disclose “***a set of target weight functions to provide a gain for weighting each target focus point depending upon the position of each target focus point relative to a particular target beam shape***” as claimed by the Applicant.

Further, with respect to the “upper beamformer” of the ***Nordholm*** reference, the Office Action has clearly mischaracterized both its function and its capabilities. For example, the ***Nordholm*** reference describes both the “upper beamformer” and the “lower beamformer” on page 243. Specifically, ***Nordholm*** explains that the “input signals to the upper beamformer… contain the microphone signal only…” In addition, ***Nordholm*** also explains on page 243 that the lower beamformer uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input to determine filter weights which are then passed to the upper beamformer for use with the current microphone array input.

Clearly, the dual-level beamformer process based on the use of live and pre-recorded signals described by the ***Nordholm*** reference fails completely to disclose or in any way render obvious any process for “computing a set of potential beams by computing a set of normalized weights for fitting the directivity pattern of each microphone into each target beam shape throughout the range of target beam widths across a frequency range of interest for each weighted target focus point; identifying a set of beams by computing a total noise energy for each potential beam across a frequency range of interest, and selecting each potential beam having a lowest total noise energy for each of a set of

frequency bands across the frequency range of interest" as disclosed and claimed by the Applicants.

In summary, Applicants claim a system that is specifically directed at automatically designing an optimized set of steerable beams for microphone arrays of arbitrary geometry and microphone type by determining optimal beam widths as a function of frequency to provide optimal signal-to-noise ratios for in-beam sound sources while providing optimal attenuation or filtering for ambient and off-beam noise sources. This automatic beamforming involves a novel process that automatically determines optimal frequency-dependant beam widths given local noise conditions and microphone array operational characteristics. Claim 15, as drafted, specifically defines the elements and limitations of these points. In contrast, the elements of claim 15 are clearly not disclosed by the ***Nordholm*** reference.

Therefore, in view of the preceding discussion, it is clear that independent claim 15 has elements not disclosed in the ***Nordholm*** reference. Consequently, the rejection of claim 15 under 35 USC §103(a) is not proper. Therefore, Applicants respectfully traverse the rejection of claim 15 and request reconsideration of the rejection of claim 15, and thus of dependent claims 16, 18-20 and 22, under 35 USC §103(a) in view of the language of claim 15. In particular, claim 15 recites the following novel language:

> "A system for automatically designing beam sets for a sensor array, comprising:
>
> monitoring all sensor signal outputs of a sensor array having a plurality of sensors, each sensor having a known geometry and directivity pattern;
>
> ***generating at least one noise model*** from the sensor signal outputs;
>
> ***defining a set of target beam shapes*** as a function of a set of target beam focus points and a range of target beam widths, said target beam focus points being spatially distributed within a workspace around the sensor array;

defining a set of target weight functions to provide a gain for weighting each target focus point depending upon the position of each target focus point relative to a particular target beam shape;

computing a set of potential beams by computing a set of normalized weights for fitting the directivity pattern of each microphone into each target beam shape throughout the range of target beam widths across a frequency range of interest for each weighted target focus point;

identifying a set of beams by computing a total noise energy for each potential beam across a frequency range of interest, and selecting each potential beam having a lowest total noise energy for each of a set of frequency bands across the frequency range of interest." (emphasis added)

2.3 <u>Rejection of Claims 26-28:</u>

In general, the Office Action rejected independent claim 26 under 35 USC §103(a) based on the rationale that the ***Nordholm*** reference teaches the Applicants' claimed "…computer executable instructions for automatically designing a set of steerable beams for processing output signals of a microphone array …" However, in view of the following discussion, Applicants will show that the ***Nordholm*** reference does not teach the Applicants claimed computer executable instructions, and that the ***Nordholm*** reference has been mischaracterized in an attempt to show some equivalence to the claimed computer executable instructions. As such, Applicants respectfully traverse the rejection of claims 26-28 under 35 USC §103(a) over the ***Nordholm*** reference.

Further, Applicants note that in rejecting independent claim 26, the Office Action merely states "Claim 26 has been analyzed and rejected according to claim 1." However, claim 26 includes a set of limitations that differ from the limitations specified in claim 1. As such, the rejection of claim 1 fails to specifically address all of the limitations of independent claim 26. Therefore, since the specific limitations of claim 26 are not

addressed in rejecting claim 26, Applicants respectfully suggest that the Office Action has failed to present the *prima facie* case for rejection required under M.P.E.P. Section 706.02(j). However, since several of the limitations of claim 26 are similar to some of the elements of claim1, Applicants will attempt to address the rejection of claim 26 in view of the rejection of claim 1.

First, Applicants respectfully suggest that the ***Nordholm*** reference fails completely to disclose or in any way render obvious any of the elements of the claimed computer executable instructions since the ***Nordholm*** reference is not directed at the same problem solved by the claimed computer executable instructions and fails to disclose or render obvious any of the elements of the claimed computer executable instructions. For example, the ***Nordholm*** reference discloses a technique for using a ***calibration signal*** as part of an analytical evaluation that ***requires a person to read representative sentences*** that are combined and processed in order to calibrate a microphone array. See for example, FIG. 1 and Section II (page 242) of the ***Nordholm*** reference, which includes the following discussion of the "Calibration Phase" of operations:

> "*A. Description of the Calibration Phase*
>
> The adaptive beamformer can be ***calibrated on site in a parked car (see Fig. 1) by emitting calibration signals from the existing hands-free loudspeaker and by letting a talker read representative sequences either directly or via a loudspeaker in what would be the talker's position***. The environmental noise level in a parked car is very low, thereby providing a good SNR during recording. These sequences are gathered into a memory. This means that information about the paths of acoustic propagation from the sources to A/D-converters are included. The beamformer has shown robust behavior with respect to changes in the driving conditions, number of passengers, etc. This is at least valid for suppressions of the hands-free loudspeaker (jammer) up to 15 dB. Experience shows that a set of gathered calibration signals can be used for

> weeks. To obtain suppression ratios of more than 25 dB, it is necessary to gather and recalibrate more frequently." (emphasis added)

In contrast, the claimed computer executable instructions do not use a calibration signal of any kind. Further, the claimed computer executable instructions do not require a person to read representative sentences either with or without the presence of a calibration signal. In addition, unlike the ***Nordholm*** reference the claimed computer executable instructions is not directed at calibrating a microphone array using combinations of discrete speech and calibration signals.

More specifically, in rejecting claim 1, the Office Action first suggests that FIG. 3 of the ***Nordholm*** reference discloses the use of "…pre-computed noise models…" However, FIG. 3 of the ***Nordholm*** reference simply does not show the use of models of noise, nor is any discussion of models of noise found in the text of the ***Nordholm*** reference. In particular, FIG. 3 of the ***Nordholm*** reference shows three inputs, as follows: 1) an input signal x(t) provided to a box labeled "Anti-Aliasing and A/D Conversion"; 2) a pre-recorded copy of the "calibration signal" being provided via a box labeled "Memory Jammer calibration signals"; and 3) a pre-recorded copy of a person reading sentences in a "parked car."

In fact, in the last sentence on page 242, ***Nordholm*** discusses the "Jammer Calibration Signal" by explaining that "The stored jammer and target (desired) signals are known ***<u>noise-free signals</u>*** (see Fig. 1)…" Clearly, the "calibration signal" is not a "model of noise" since it is a "known noise free signal." Similarly, the recorded speech of a person reading sentences in a parked car is not a "model of noise." Finally, the real-time signal input x(t) is clearly not a "model of noise." As such, it is clear that FIG. 3 of the ***Nordholm*** reference fails to disclose the use of "models of noise."

Next, in rejecting claim 1, the Office Action suggests that Section II, beginning on page 242, of the ***Nordholm*** reference (entitled "Working Scheme for the Adaptive Beamformer") discloses the claimed element of "***compute a set of complex-valued gains***

for each subband of a frequency-domain decomposition of microphone array signal inputs for each of a plurality of beam widths within a range of beam widths, said sets of complex-valued gains being computed from the pre-computed noise models in combination with known geometry and directivity of microphones comprising the microphone array…" Claim 26 contains a similar element of somewhat different scope. Specifically, Claim 26 recites "***computing sets of complex-valued gains for each of a plurality of beams through a range of beam widths for each of a plurality of target focus points*** around the microphone array from a set of parameters, said parameters including one or more models of noise of an environment within range of microphones in the microphone array and known geometry and directivity patterns of each microphone in the microphone array…"

Consequently, since both claim 1 and claim 26 recite an element relating to sets of "complex-valued gains," Applicants assume that the rejection of the element in claim 1 is intended by the Office Action to refer to the similar element in claim 26. However, in contrast to the position advanced by the Office Action, it is clear that the ***Nordholm*** reference fails completely to disclose the aforementioned element of claim 26, or in any way render that element obvious. For example, Section II of the ***Nordholm*** reference clearly describes the use of a generic beamformer which is summarized by the use of Equation (2) which illustrates a generic technique for providing a beamformer output $u[k]$ from a weighted beamformer input (see page 243 of the ***Nordholm*** reference). More specifically, as illustrated by FIG. 3 of the ***Nordholm*** reference, the "Upper Beamformer" output $u[k]$ is computed based on the microphone array signal input in combination with an output from a "lower beamformer" that is computed based on a combination of previously recorded speech, previously recorded calibration signals, and a copy of the microphone array input.

In contrast, Applicants specifically claim "…***<u>computing sets of complex-valued gains</u> for each of a plurality of beams through a range of beam widths <u>for each of a plurality of target focus points</u>***…" This feature is simply not disclosed or in any way rendered obvious by the ***Nordholm*** reference.

Next, in rejecting claim 1, the Office Action suggests that the "Upper Beamformer" of the ***Nordholm*** reference discloses the claimed element of "***search the sets of complex-valued gains to identify a single set of complex-valued gains for each frequency-domain subband and for each of a plurality of target focus points around the microphone array***..." Claim 26 does not specifically include a corresponding element. However, to address this point, it has been established that the ***Nordholm*** reference fails to disclose any process for "***computing sets of complex-valued gains***..." as claimed by the "***sets of complex-valued gains***..." in the manner claimed by the Applicants.

Further, the ***Nordholm*** reference describes both the "Upper Beamformer" and the "lower beamformer" on page 243. For example, ***Nordholm*** explains that the "input signals to the upper beamformer... contain the microphone signal only..." In addition, ***Nordholm*** also explains on page 243 that the lower beamformer uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input to determine filter weights which are then passed to the upper beamformer for use with the current microphone array input. Clearly, the dual-level beamformer process based on the use of live and pre-recorded signals described by the ***Nordholm*** reference fails completely to disclose or in any way render obvious any process for processing the "***sets of complex-valued gains***..." in the manner claimed by the Applicants.

Finally, in rejecting claim 1, the Office Action suggests that the ***Nordholm*** reference discloses the claimed element of "***wherein each said set of complex-valued gains is individually selected as the set of complex-valued gains having a lowest total noise energy relative to corresponding sets of complex-valued gains for each frequency-domain subband*** for each target focus point around the microphone array" (emphasis added). Claim 26 includes similar limitations, expressed in two separate elements, which have a somewhat different scope than that of the limitation in claim 1. In particular, claim 26 recites "***computing a lowest total noise energy for each set of complex-valued gains for each target focus point*** for each beam width; and ***identifying the sets of complex-valued gains and corresponding beam width having the lowest***

total noise energy for each target focus point, and ***selecting each such set as a member of the set of steerable beams for processing the output signals of a microphone array***."

With respect to the rejection of claim 1, the Office Action suggests that this feature, which limits the selection of the claimed set of complex-value gains, is disclosed by the "Upper Beamformer output" as illustrated by FIG. 3 of the ***Nordholm*** reference. The Office Action then continues in the rejection of this element of claim 1 by suggesting that the remainder of the element, which recites "***wherein each selected set of complex-valued gains is then provided as an entry in said beam set for the microphone array***" (emphasis added) is disclosed by the "Lower Beamformer" of the ***Nordholm*** reference.

There are several problems with this last argument presented by the Office Action with respect to this last element of claim 26. For example, the Office Action is apparently suggesting that the "Upper Beamformer output" discloses the claimed "sets of complex value gains." However, the output of the "Upper Beamformer" is a ***<u>time-domain audio signal</u>***, $u[k]$. Clearly, a time-domain audio signal is ***not*** a set of complex-value gains.

Further, this time-domain audio signal output by the Upper Beamformer is ***not*** provided back to the "Lower Beamformer" as suggested by the Office Action (see the very large arrow pointing from the Lower Beamformer to the Upper Beamformer in FIG. 3 of the ***Nordholm*** reference. Specifically, the Office Action suggests that the output of the Upper Beamformer is provided to the Lower Beamformer and that this somehow discloses the claimed element of "***wherein each selected set of complex-valued gains is then provided as an entry in said beam set for the microphone array***."

Applicants respectfully suggest that this is a clear mischaracterization of the ***Nordholm*** reference since, as discussed above, the Lower Beamformer of the ***Nordholm*** reference simply uses stored signals (speech and calibration signal, as described above) in combination with a current microphone input t***o determine filter weights which are then passed to the upper beamformer*** for use with the current microphone array input.

In summary, Applicants claim a computer executable instructions that is specifically directed at automatically designing an optimized set of steerable beams for microphone arrays of arbitrary geometry and microphone type by determining optimal beam widths as a function of frequency to provide optimal signal-to-noise ratios for in-beam sound sources while providing optimal attenuation or filtering for ambient and off-beam noise sources. This automatic beamforming involves a novel process that automatically determines optimal frequency-dependant beam widths given local noise conditions and microphone array operational characteristics. Claim 26, as drafted, specifically defines the elements and limitations of these points. In contrast, the elements of claim 26 are clearly not disclosed by the ***Nordholm*** reference.

Therefore, in view of the preceding discussion, it is clear that independent claim 26 has elements not disclosed in the ***Nordholm*** reference. Consequently, the rejection of claim 26 under 35 USC §103(a) is not proper. Therefore, Applicants respectfully traverse the rejection of claim 26 and request reconsideration of the rejection of claim 26, and thus of dependent claims 27-28, under 35 USC §103(a) in view of the language of claim 26. In particular, claim 26 recites the following novel language:

> "A computer-readable medium having computer executable instructions for automatically designing a set of steerable beams for processing output signals of a microphone array, said computer executable instructions comprising:
>
> ***computing sets of complex-valued gains for each of a plurality of beams through a range of beam widths for each of a plurality of target focus points around the microphone array from a set of parameters***, said parameters including one or more models of noise of an environment within range of microphones in the microphone array and known geometry and directivity patterns of each microphone in the microphone array;
>
> wherein ***each beam is automatically selected throughout the range of beam widths using a beam width angle step size for selecting specific beam widths across the range of beam widths***;

> ***computing a lowest total noise energy for each set of complex-valued gains for each target focus point for each beam width***; and
>
> ***identifying the sets of complex-valued gains and corresponding beam width having the lowest total noise energy for each target focus point, and selecting each such set as a member of the set of steerable beams*** for processing the output signals of a microphone array." (emphasis added)

3.0 Rejection of Dependent Claims under 35 U.S.C. §103(a):

The Office Action rejected dependent claims 2, 8, 10-14, 17, 21, 23-25, and 29-35 under 35 U.S.C. §103(a) based on the rationale that the ***Nordholm*** reference discloses the Applicants claimed methods, systems and computer-readable media, when combined with various additional references. However, as discussed above in Sections 2.1 through 2.3, the parent claims (i.e., claims 1, 15 and 26) of dependent claims 2, 8, 10-14, 17, 21, 23-25, and 29-35 have been shown to be allowable in view of the cited ***Nordholm*** reference. Therefore, the use of additional references in an attempt to address particular features of various dependent claims fails to show a *prima facie* case of obviousness as required under 35 U.S.C. §103(a). Therefore, the Applicants respectfully traverse the rejection of claims 2, 8, 10-14, 17, 21, 23-25, and 29-35 in view of the patentability of their respective parent claims, as discussed above.

CONCLUSION

In view of the above, it is respectfully submitted that claims 1-35, as amended, are in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of claims 1-35 and to pass this application to issue. Additionally, in an effort to further the prosecution of the subject application, the Applicant kindly invites the Examiner to telephone the Applicant's attorney at (805) 278-8855 if the Examiner has any questions or concerns.

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